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Data acquisition system for the J-PARC E36 experiment

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An experiment to test Lepton Flavor Universality (LFU) using a precise measurement of the decay width ratio of the two body kaon decay to a positron and a muon (J-PARC E36), completed data taking in Dec 2015. The experiment was performed on the K1.1BR beam-line at the Japan Proton Accelerator Research Complex (J-PARC) Hadron hall. The K1.1BR beam-line is a low momentum kaon beam line for stopped kaon measurements. The E36 detector system employed a12 sector icon-core superconducting spectrometer for the momentum analysis of the two body decays, three types of PID detectors (TOF, Aerogel Cherenkov and Lead glass counters) to discriminate Ke2/Kmu2 decays, an active segmented scintillator target to identify the kaon stopping position and outgoing lepton track, and a CsI(Tl) photon detector (PD) to study the radiative decays as a background.

We developed and constructed the data acquisition (DAQ) system for this experiment. The DAQ system had to integrate several traditional and also more recent types of read-out systems to satisfy the experimental requirements. The DAQ system had the traditional TKO ADC/TDC (TKO is a KEK local standard DAQ readout system) for TOF, VME based ADC/TDC for many PMTs, VME based waveform sampler (VF48 developed by TRIUMF) for the CsI(Tl) PD and a network oriented special readout board for the small SiPM detectors used for the active scintillator target.
We used a common event synchronization method by the distributing the event identify number, called the Event Tag, and a common network to integrate the different types of readout systems. The Event Tag distributing system can distribute a unique serial number to all DAQ readout devices with the trigger signal. All the front-end readout systems, except the VME waveform sampler, had a port to receive the Event Tag. For the case of the VME waveform sampler, the Event Tag was encoded as an analogue signal and it was sampled by the VME waveform sampler along with the detector signals. The data fragments can thus be identified by this Event Tag. A network-based event-builder collected the event fragments from each front-end readout device via Ethernet. The TKO and the VME read-out systems were controlled by PC based VME single board computers. These single board computers send their collected data to the event-builder by the Ethernet. The MPPC readout board has a front-end ASIC named EASIROC (developed by Omega IN2P3), an FPGA based controller and an FPGA based TCP/IP network engine. Therefore, this board can send its recorded data to the network by itself without requiring any additional controller. The entire DAQ system worked stably during the experiment data taking with around 10 % dead-time at a trigger rate of 250 Hz.

Author: Dr IGARASHI, Youichi (High Energy Accelerator Research Organizaiton (KEK), Japan)

Co-authors: Dr LU, Haiyun (University of Iowa, USA); Mr TANUMA, Ryosuke (Riken, Japan)

Presenter: Dr IGARASHI, Youichi (High Energy Accelerator Research Organizaiton (KEK), Japan)

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